DEFINING LONG-DURATION TRAVERSES OF LUNAR VOLCANIC COMPLEXES WITH LROC NAC IMAGES.

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Introduction: A long-duration lunar rover [e.g., 1] would be ideal for investigating large volcanic complexes like the Marius Hills (MH) (~300 x 330 km), where widely spaced sampling points are needed to explore the full geologic and compositional variability of the region. Over these distances, a rover would encounter varied surface morphologies (ranging from impact craters to rugged lava shields), each of which need to be considered during the rover design phase.

Previous rovers including Apollo, Lunokhod, and most recently Yutu, successfully employed pre-mission orbital data for planning (at scales significantly coarser than that of the surface assets). LROC was specifically designed to provide mission-planning observations at scales useful for accurate rover traverse planning (crewed and robotic) [2]. After-the-fact analyses of the planning data can help improve predictions of future rover performance [e.g., 3-5].

Results and Conclusions: Previously, using a path-planning tool [6] that relates anticipated terrain directly to engineering parameters along with LROC NAC images and derived Digital Terrain Models (DTMs), we characterized slopes, terrain roughness, and potential hazards for the future exploration of a variety of lunar volcanic deposits [7]. Here, we also directly compare a notional MH traverse (in an established "rough terrain" [e.g., 8-11]) to the Apollo 15 (A15) EVAs (in "smooth mare" [e.g., 3,10,12]) using NAC DTMs (Fig. 1).

The notional MH traverse is dominated by slopes <2° (calculated from elevations extracted along the traverse), similar to both of the reconstructed A15 EVAs (Fig. 1). Local slopes between 5 and 10° (from NAC DTMs) are more abundant than was previously determined along the A15 EVAs using 20 m topographic data [3, their Fig. 16]. Slopes of 10-20° are only a minor part, ~3%, of the overall MH and reconstructed A15 EVAs. A maximum navigable slope of 20° was assumed for the MH traverse. The measured slopes of the notional MH traverse, compared to the NAC analysis of the A15 EVAs, suggest that the MH path is viable for future roving.

References: [1] Robinson et al. (2011) LEAG #2042. [2] Robinson et al. (2010) Space Sci. Rev. 10.1007/s11214-010-9634-2. [3] Costes et al. (1972) NASA TR-R401. [4] Basilevsky et al. (2015) PSS 10.1016/j.pss. 2015.08.006. [5] Karachevtseva et al. (in press) Icarus 10.1016/ j.icarus.2016.05.021. [6] Speyerer et al. (2016) Icarus 10.1016/ j.icarus.2016.03.011. [7] Stopar et al. (2013) LEAG #7038. [8] Stopar et al. (2016) LPSC #2555. [9] Campbell et al. (2009) GRL 10.1029/ 2009GL041087. [10] Carrier et al. (1991) Lunar Sourcebook, Ch 9. [11] Lawrence et al. (2013) JGR-P, 10.1002/jgre.20060. [12] Lawrence et al. (2015) LEAG #2074.

Fig. 1: Apollo 15 EVAs and a notional MH traverse of comparable length (yellow lines). Plot of slope distributions for traverses: A15 (derived from a NAC DTM with pixel scale 1.5-m, and post-mission analysis of 20-m pixel scale maps [3]) and MH (derived from NAC DTM, pixel scale 2-m).